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Brookhaven Medical Research Reactor

Facility Environmental Monitoring Report

Calendar Year 2003

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Summary of Results

Although the BMRR was shut down in December 2000, BNL has maintained the semi-annual emissions monitoring program to verify that radionuclide emissions are diminishing as anticipated. Emissions monitoring during 2003 confirmed that no radionuclides are being emitted from the BMRR facility.

Historically, tritium concentrations in the BMRR air conditioning condensate have ranged from non-detectable levels to a maximum of 40,000 pCi/L. During 2003, tritium was detected in one sample collected in December at a concentration of 15,300 pCi/L. Due to the low volume of release, these discharges have had no impact on the Sewage Treatment Plant influent and effluent tritium concentrations.

Tritium continues to be detected in groundwater downgradient of the BMRR, but at concentrations well below the 20,000 pCi/L drinking water standard. During CY 2003 the maximum observed tritium concentration was only 892 pCi/L.

Background

The Brookhaven Medical Research Reactor (BMRR) is a 3 MW light water reactor that was used for biomedical research. Research operations at the BMRR stopped in December 2000, and BNL is preparing plans to permanently decommission the facility.[1]

Comment [KR1]: We need to say whether the fuel removal occurred in 2002 as scheduled, and if all primary cooling water was drained.

The BMRR's primary cooling water system consists of a recirculation piping system that contains 2,550 gallons of highly tritiated water. Unlike the High Flux Beam Reactor (HFBR), the BMRR does not have a spent fuel storage canal or pressurized embedded piping systems that contain radioactive liquids. Historically, fuel elements that required storage were either stored within the reactor vessel or were transferred to the HFBR spent fuel canal. The primary system's piping is fully exposed within the containment structure and is accessible for routine visual inspections. The primary cooling water currently contains approximately 5 Ci of tritium (Rooks, 2004). When the BMRR was operational, excess heat was transferred by means of heat exchangers with once-through (secondary) cooling water that was obtained from former Process Well 105 or the BNL Chilled Water System. This secondary water was discharged to recharge basin HP (SPDES Outfall 004) located 800 feet to the south of the Medical Department complex. These discharges were monitored as part of the State Pollutant Discharge Elimination System (SPDES) program.

To cool the neutron reflector surrounding the core of the BMRR reactor vessel, air from the interior of the containment building was used. When air was drawn through the

[1] All fuel has been removed from the BMRR, and plans are being prepared to drain the primary cooling water system.

reflector, it was exposed to a neutron field that caused the argon component of the air to become radioactive. This radioactive form is known as argon-41, which is a chemically inert gas with a half-life of only 1.8 hours. After passing through the reflector, air was routed through a roughing filter and a high efficiency particulate air (HEPA) filter to remove any particulate matter, then finally through a charcoal filter to remove radioiodines produced by the fissioning of fuel. Following filtration, the air was vented to a 150-foot stack adjacent to the reactor containment building. Although the facility is inactive, a real-time monitor continues to track potential remnant argon-41 air emissions, while passive filter media are used to collect and quantify radioiodines and particulates.

In 1997, tritium was detected in wells installed directly downgradient (within 30 feet) of the BMRR. The maximum tritium concentration during 1998 was 11,800 pCi/L, almost one-half of the drinking water standard of 20,000 pCi/L. Small amounts of tritium may have been released to the soils below the BMRR when primary cooling water was periodically drained to a basement floor drain and sump system that did not have secondary containment or leak detection. Although the last discharge of primary cooling water to the floor drain system occurred in 1987, the floor drains continued to be used for secondary (nonradioactive) cooling water until 1997. Infiltration of this water may have promoted the movement of residual tritium from the soils surrounding the floor drain piping system to the groundwater. The floor drains were permanently sealed in 1998 to prevent any accidental future releases to the underlying soils.

Environmental Monitoring Program

The environmental monitoring program for the BMRR is described in the BNL Environmental Monitoring Plan (BNL, 2003). The BMRR monitoring results and recommendations are summarized below.

Monitoring Results

Air Monitoring

Since the BMRR was shut down in December 2000, BNL has maintained semiannual monitoring of argon-41 emissions, and passive filter media have been used to collect and quantify radioiodines and particulates. Periodic monitoring was implemented at the BMRR facility in accordance with NESHAP requirements to confirm that the air concentrations for radionuclides remain below detection levels. When BMRR was operational, it was a major point source of airborne radioactive emissions released from the BNL site, with argon-41 consistently contributing the largest fraction of all radionuclide activity released. Historically, argon-41 was the only radionuclide that had the potential to contribute a small fraction of dose to members of the public. Following the termination of reactor operations, the emission of particulates, radioiodines, and argon-41 has been insignificant.

In January 2003, the fuel was removed from the BMRR reactor vessel. The removal of the fuel and cessation of reactor operations eliminated any potential for radionuclide emissions to the environment. As anticipated, monitoring of BMRR emissions during 2003 did not detect any reactor-derived radionuclides (Tables 2 and 3). In September 2003, a request was made to the US EPA to terminate emissions monitoring at the BMRR facility. In response, the US EPA requested clarification previously submitted sampling data, and requested that additional emissions sampling be conducted. This information was provided to the US EPA in early 2004.

Groundwater Monitoring

Groundwater samples are collected from four monitoring wells (Figure 1). Monitoring results for 2003 indicate that tritium concentrations continued to be well below the 20,000 pCi/L drinking water standard. Detectable levels of tritium were observed in two of the three downgradient wells, with the maximum value of 892 pCi/L in Well 084-27 (Table 1 and Figure 2). Note: groundwater monitoring conducted from 1997 though 2001 did not detect any other reactor-related radionuclides using gamma spectroscopy, gross alpha/beta, or strontium-90 analyses. Therefore monitoring conducted during 2002-2003 focused on tracking tritium concentrations in the groundwater.

SPDES Monitoring

As noted above, once-through cooling water was used to cool the BMRR. Discharges from this system were release to a recharge basin south of the BMRR (Outfall 004), and were monitored in accordance with the SPDES permit. Water discharges from the BMRR were permanently discontinued in June 2001, and a request to end the discharge-monitoring program for this outfall was approved by NYSDEC in February 2002. Consequently, there were no samples collected from this outfall in 2003.

Discharges to Sanitary

Periodically, small volumes of BMRR air conditioning condensate are discharged to the BNL sanitary system. This water is monitored for tritium to ensure the concentrations remain within BNL release criteria. Historically, tritium concentrations in the condensate have ranged from non-detectable levels to a maximum of 40,000 pCi/L. During 2003, tritium was detected in one sample collected in December at a concentration of 15,300 pCi/L. Due to the low volume of release, these discharges have had no impact on the Sewage Treatment Plant influent and effluent tritium concentrations.

Future Monitoring Actions

The following actions will take place during the CY 2004 monitoring period:

- Continue to sample the monitoring wells on a semiannual basis. Analyze samples for tritium. If tritium concentrations remain at low levels, the monitoring frequency will be reduced to annually starting in CY 2005.

- The emissions monitoring program will be terminated upon US EPA approval.
- Continue testing air conditioning condensate for tritium.

References

BNL. 2003. *Brookhaven National Laboratory Environmental Monitoring Plan Triennial Update 2003*. BNL-52676. Brookhaven National Laboratory, Upton, NY. January 2003.

Rooks, R. 2004. E-mail memorandum to D. Paquette (June 4, 2004).

Table 1. CY 3003 Groundwater Tritium Results for BMRR Monitoring Wells.

Well	Location	Collection Date	Tritium Result	Tritium MDL
			-------------------------------pCi/L-------------------------------	
84-28	Upgradient of BMRR	03-11-03	<352	352
		09-08-03	<326	326
84-12	Downgradient of BMRR	03-04-03	<318	318
		09-08-03	563 +/- 255	326
84-13	Downgradient of BMRR	03-04-03	<318	318
		09-08-03	<326	326
84-27	Downgradient of BMRR	03-11-03	892 +/- 318	352
		09-08-03	<326	326
Drinking Water Standard			20,000	

Notes:
MDL = Minimum Detection Limit
"<" preceding a value (e.g., <362) indicates that the measured value was less than the stated MDL.

Table 2. BMRR Continuous Emissions Monitoring Data

Comparison 1999-2003 Ar-41 (half life: 1.8 hours)					
Curies					
	BMRR Period of Operation		**BMRR Shut-Down**		**Fuel Removed**
	1999	**2000**	**2001**	**2002**	**2003**
January	73.92	289.72	Non-detect	Non-detect	Non-detect
February	171.20	206.92	Non-detect	Non-detect	Non-detect
March	154.52	168.43	Non-detect	Non-detect	Non-detect
April	297.35	180.90	Non-detect	Non-detect	Non-detect
May	105.00	139.02	Non-detect	Non-detect	Non-detect
June	132.87	228.13	Non-detect	Non-detect	Non-detect
July	115.06	199.17	Non-detect	Non-detect	Non-detect
August	174.69	191.50	Non-detect	Non-detect	Non-detect
September	78.47	223.76	Non-detect	Non-detect	Non-detect
October	116.97	188.97	Non-detect	Non-detect	Non-detect
November	63.45	78.15	Non-detect	Non-detect	Non-detect
December	156.77	93.96	Non-detect	Non-detect	Non-detect
Total	**1640.27**	**2188.63**			

Table 3. Summary of Tritium and Gamma Results for BMRR Matrices

Comparison 1999-2003 (all identified radionuclides)					
	BMRR Period of Operation		BMRR Shut-Down		Fuel Removed
Sample Type	1999**	2000**	2001	2002	2003
Charcoal (Gamma)	Cl-38: 2.4E-08 µCi/cc Xe-135: 1.2E-09 µCi/cc Xe-135m: 1.3E-09 µCi/cc	Cl-38: 2.4E-08 µCi/cc Xe-135: 8.29E-10 µCi/cc Xe-135m: 9.47E-10 µCi/cc	No Nuclides Identified*	K-40: 8.59E-11 µCi/cc	K-40: 1.0E-10 µCi/cc Pb-214: 6.83E-12 µCi/cc
Particulate Filter (Gamma)	Rb-89: 7.9E-08 µCi/cc Sr-91: 5.9E-11 µCi/cc Cs-138: 5.6E-10 µCi/cc Ba-139: 3.5E-10µCi/cc	Rb-89: 7.2E-10 µCi/cc Sr-91: 5.5E-11 µCi/cc Cs-138: 4.5E-10 µCi/cc Ba-139: 3.4E-10µCi/cc	No Nuclides Identified*	No Nuclides Identified* Pb-214: 2.16E-13 µCi/cc	No Nuclides Identified* K-40: 1.7E-11 µCi/cc
Primary Water (Gamma)	Not sampled (Operational)	Not sampled (Operational)	Co-60: 1.53E-07 µCi/ml Cs-137: 1.64E-06 µCi/ml	No Nuclides Identified*	No Nuclides Identified*
Primary Water (Tritium)	Not sampled (Operational)	Not sampled (Operational)	5.71E-01µCi/ml	5.24E-01 µCi/ml	5.6E-01 µCi/ml
Exhaust Air (Gamma)	Xe-135: 1.77E-07 µCi/cc Xe-138: 3.58E-06 µCi/cc Rn-219: 1.65E-06 µCi/cc	Kr-87: 3.94E-07 µCi/ml Xe-135: 1.45E-07 µCi/ml Rn-219: 2.80E-06 K-40: 1.0E-10 µCi/cc	No Nuclides Identified*	No Nuclides Identified*	No Nuclides Identified*

*: *The statement "there are no nuclides meeting summary criteria" is used when no radionuclide can be identified from the software program library of radionuclides (approximately 220 radionuclides). The software program uses the following criteria for positive identification of a nuclide:*

- *The total propagated error for the nuclide must be less than 80%.*
- *The nuclides key line must be identified in the spectrum.*
- *The resolution of the key line must be less than 2.5 FWHM.*
- *The activity to MDA ratio must be greater than 1.0 (generally >1.6).*
- *The difference of 1-sigma error subtracted from the activity must be greater than MDA.*

**: The radionuclides identified in 1999 and 2000 are short-lived radionuclides, and are listed for comparison purpose only. They did not contribute to the effective dose equivalent in amounts greater than 10% of the NESHAPs standard. Ar-41 was the major radionuclide that contributed to dose and is listed in Table 2.

Figure 1. BMRR Area Groundwater Monitoring Wells.

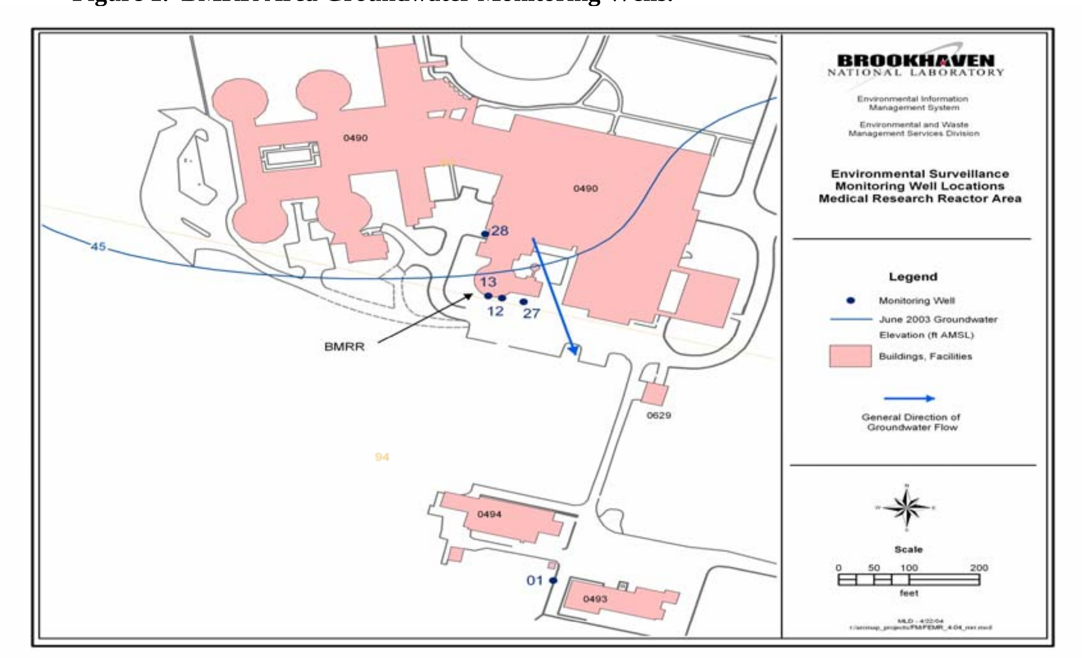

Figure 2. Tritium Concentrations at the BMRR 1997–2003.